ANALYSIS OF 1987 FLOOD OF WEST MEMPHIS, ARKANSAS

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STATEMENT OF PROBLEM AND PURPOSE

The flooding that occurred in West Memphis, Arkansas, was an unusual phenomenon due to its magnitude and extent. Some places flooded beyond the 500-year flood boundary. The heavy damage and destruction encountered during this flood could have been reduced if proper and better executed measures had been implemented.

On December 26, 1987, Governor Clinton of Arkansas declared a state of emergency and requested a federal disaster declaration. On December 31, the President of the United States declared Arkansas a major disaster area and made Crittenden County eligible for individual assistance programs.(1) The reason for these declarations was a four-day heavy-rain event in extreme Eastern Arkansas. In many places this flood affected more areas than the 500-year flood plain boundary as defined by Federal Emergency Management Agency (FEMA). The focus of this paper is the nature and causes of this flood and possible ways to reduce future flooding problems.

STUDY AREA

West Memphis is located in the eastern part of Crittenden County, Arkansas. The county has a population of approximately 48,000. The economy is basically an industrial and commercial mix, with decreasing amounts of farming. Wholesale and retail trade provide 65 percent of the total employment. Most of the industrial and commercial activity in Crittenden County occurs in West Memphis with a population of nearly 28,000.(2) The landscape is basically level and poorly drained.

DATA SOURCES

The primary data source concerning flooding conditions in Crittenden County is the United States Corps of Engineers, with some supplemental information from the United States Geological Survey office. Precipitation and temperature data for the December 1987 flood were acquired from Memphis Weather Service. Aerial photographs were also used to determine the flooding boundaries and to delineate possible obstructions that contributed to the flooding situation. Soil survey and topographic maps were used to analyze the physical environment in West Memphis. More precise and beneficial data will be available in the future due to the fact that additional studies are currently being conducted in West Memphis.

DISCUSSION AND ANALYSIS OF THE PHYSICAL CHARACTERISTICS

(1) Heavy-Rain Event: West Memphis, Arkansas was severely flooded by a heavy-rain event that occurred between December 24, 1987, and December 28, 1987. The heavy rain was caused by the collision of a strong southeasterly-moving cold front and moist warm air from the Gulf of Mexico. The heaviest 24-hour concentration of rain fell between 10 AM CST, December 24, and 10 AM CST, December 25. (3) Table 1 shows the precipitation data for the West Memphis, Arkansas, heavy-rain event. A report done by the Memphis Office of the National Weather Service titled "Christmas Rains of 1987" states that this district can expect rain of 10 to 11 inches of rain once every 500 years, a 0.2 percent annual probability. The report also states that a 24-hour rain of 8 inches can be expected only once a century, a one percent annual probability.(4)

TABLE 1 Precipitation of December, 1987 Flood West Memphis, Arkansas

Date	Precipitation
December 24	1.73
December 25	7.25
December 26	1.60
December 27	1.20
December 28	1.01
Event Total	12.79

Source: NOAA. "Christmas Rains of 1987." 1988. p. 1-3.

(2) Soil Analysis: In the West Memphis area, there are basically four different soils which make up the ground cover. These soils are Alligator silty clay, Bowdre silty clay, Sharkey silty clay, and Tunica clay.(5) Alligator clay has a depth of 0 to 4 inches from the surface in this area. It has a 0.06 to 0.20 inches per hour permeability and an available water capacity of 0.18 to 0.20 inches per inch of soil. The seasonal high water table is less than 0.5 inches. Bowdre silty clay has a depth from surface of 0 to 17 inches. Bowdre silty clay has the same permeability and water capacity as Alligator clay, but Bowdre has

a seasonal high-water table depth of 4 to 6 inches. Sharkey silty clay has a depth of 0 to 8 inches from the surface. It also has the same permeability and water capacity as the two previous soils. Sharkey clay has a depth to seasonal high-water table of less than 0.5 inches. The last predominant soil in the region, Tunica clay, has a depth from the surface ranging from 0 to 20 inches. Tunica clay has less than 0.065 inches per hour permeability and a water capacity comparable to the other soils. The depth to seasonal high water table is less than 0.5 inches. All four of these soils have a high shrink-swell potential, thus making them very unstable.

As a top soil, these four types are a plastic clayey material which drains poorly. They have an average soil permeability of 0.11 inches per hour or 2.64 inches in a twenty-four hour period. The water storage capacity of these soils is about 5 to 6 inches. The water table runs from one foot to 8 feet or more depending on the water level of the Mississippi River and the soil moisture content. When the storage capacity is full, as it was on December 24 from the 10.45 inches of rain in November 1987, there is a heavy runoff. Using the C. W. Thornthwaite water budget analysis program, the hydroclimatic data were calculated for the five-day heavy rain event (Table 2).

TABLE 2 Daily Water Budget, December 24 to 28, West Memphis, Arkansas

December	24	25	26	27	28	Total
Precipitation[1]	1.73	7.25	1.60	1.20	1.01	12.79
Potential Evap.[2]	0.00	0.05	0.01	0.03	0.01	0.14
Actual Evap.[2]	0.04	0.05	0.01	0.03	0.01	0.14
Surplus[2]	1.65	7.20	1.59	1.17	1.00	12.61
Runoff[2]	0.84	4.02	2.80	1.99	1.50	11.13

[1] Precipitation data from Memphis Weather Service
[2] PE, AE, Surplus, and Runoff were calculated by using the C. W. Thornthwaite water budget method.

These data clearly indicate that the storage capacity had been exceeded due to the large surplus of water and subsequent runoff. The presence of a large surplus and runoff is not enough to constitute a flood. The topography of a given area is the physical feature which often determines whether or not excessive runoff will produce a flood.

(3) Topography: In the West Memphis area, like most areas in the lower Mississippi River Alluvial Plain, the topography is level. In the alluvial plain, the topography is dominated by dried up oxbow lakes and meander scars. In the West Memphis area, past river movements have worked to shape the ground to a level surface. In the vicinity of West Memphis, the average elevation is around 210 feet, with lowest to highest ranging from 205 feet to 215 feet. The surface features that did exist were caused by the natural recession of flood waters toward the main channel of the Mississippi River to the east and St. Francis River to the west. During the 1950s and 1960s, the Corps of Engineers built levees which put an end to drainage toward the Mississippi River. The building of the levees thus caused an increase in the natural water movement toward the west. As the water tries to move west, it is confined by the combination of lack of slope in that direction and raised transportation lines. The city is a low-lying area surrounded by elevated barriers. To the north, the city is bounded by Interstate 55; to the south, by the Chicago Rock Island and Pacific Railroad and the St. Francis levee. To the east, the interstate and the railroad converge in the shape of a cone. Cutting the city in half are the elevated tracks of the St. Louis-San Francisco Railroad that run approximately north and south. The largest areas of high ground (215 feet elevation) are in the northern part of the city to the west of the St. Louis-San Francisco Railroad, and directly to the east of the railroad. These elevated barriers constrict the natural movement of rain water. This lack of movement in a natural drainage pattern has prompted the City of West Memphis to build ditches to assist in the drainage of water.

(4) Drainage: There are two primary movers of drainage in the City of West Memphis. The first is the Ten Mile Bayou which drains the central part of the city. Ten Mile Bayou is an earthen ditch which is about 8 feet deep and 15 to 30 feet wide at the crest. The Bayou runs through the city in a southwesterly direction, with mostly earthen feeder ditches spaced out along its path. Ten Mile Bayou flows at optimal capacity when it is not blocked with debris and vegetative growth, as it was in December of 1987. In many areas of West Memphis, the runoff does not have the chance to reach the bayou due to the poor topography. When the Bayou fills due to backup or excessive flow, the ditches do not drain and the city floods. In times of heavy rains, Ten Mile Bayou is often full of water by the time it reaches West Memphis due to the drainage area upstream. This area is a stretch of land which lies north of West Memphis between Marion, Arkansas, and Interstate 55. This region is mostly open ground made up of the same soils as found in the West Memphis area. Drainage in this area would not normally be a problem for West Memphis if the Missouri Pacific Railroad was not immediately north of the city. The railroad, being elevated, acts as a barrier to normal water flow and dispersion. Between Interstate 55 on the west and the levee to the east, rain water runoff has only one place to drain and that is down to Ten Mile Bayou and through West Memphis.

The second major drainage system in the West Memphis area is the Fifteen Mile Bayou. Fifteen Mile Bayou lies to the immediate west of the city and is the outlet into which Ten Mile Bayou flows. The only direct link between Fifteen Mile Bayou and the city is a diversion ditch which runs from Ten Mile Bayou across the northern part of the city. After the water reaches Fifteen Mile Bayou, it makes its way to the St. Francis River which eventually flows to the Mississippi River. At the time of the flood, the Mississippi River was at a high water stage, causing the St. Francis River to back up, which in turn slowed down the drainage capacity of Ten Mile and Fifteen Mile Bayous. The flow of water out of the West Memphis area was further hampered by the large amount of vegetative growth in many of the ditches in the West Memphis drainage pattern.

At the time of the flood, the bottoms of most of the major bayous in the area had several inches, if not feet, of eroded topsoil in them. Most of these ditches grew a heavy underbrush over several previous seasons which in some places consisted of hardwood deciduous tree saplings.

CONSEQUENCES OF FLOODS

West Memphis, Arkansas, is no stranger to flood. Damaging floods occurred there in December 1967, January 1974, April 1974, March 1975, April 1979, and December 1982. As a result of the December 1987 flood, 886 single family homes, five businesses, sixty multi-family units, and forty mobile homes received minor to severe damage. Six temporary shelters were opened by the Red Cross, with a total attendance of 641 families. By the end of January 3, 1988, a total of 936 applications for federal assistance were submitted. (1)

The city of West Memphis is a member of the National Flood Insurance Program. At the time of the flood, participation in the program was almost 100 percent. In West Memphis, there were 763 policies with a gross coverage of $32,934,700.(1) The area most affected was the lower income region located in the southern part of the city. The insurance map provided by Federal Emergency Management Agency (FEMA), which is used to determine rates based on the projected flood plain, turned out to be very similar to the actual event. When these maps are compared, one can readily see that at the peak of the flood water levels reached the 100 and 500 year projected highs. Many streets in the city, especially in the southern part, are often inundated by floods.

SOLUTIONS AND CONCLUSION

The city of West Memphis is presently conducting a comprehensive drainage study which will probably take several years to complete due to a lack of funds. The city is also in the process of cleaning out the major drains within the city. The city is also working with the Memphis district office of the Corps of Engineers in an effort to develop a large-scale plan to stop the flooding. In 1982, the Corps of Engineers published a comprehensive study for the solution of flooding in the West Memphis area. The study suggested the building of wider, concrete-lined drains along a 24 mile stretch of both the Ten and Fifteen Mile Bayou to end at the junction of Ten Mile Bayou and the St. Louis-San Francisco Railroad line in West Memphis. The plan was projected to have a more cost-effective benefit/cost ratio, with a 100 year life span. The projected cost was roughly 22 million dollars.(6) This plan failed to be implemented because the city of West Memphis could not afford the project's $1,000,000 price share.

If West Memphis is to remain relatively free of flood waters without costly improvements, the members of city government would find it most advantageous to invest a little time and money in preventive measures. First, they need to remember that rain is one thing they can count on seeing again. Second, they need to determine the drainage abilities of given areas and make ordinances that are appropriate. Third, they need to have an annual cleaning program for city ditches. Lastly, they need to actively search out methods by which they can obtain the funds that are necessary to make needed improvements.

REFERENCES

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